

Pricing Strategy Analysis for Collective Purchasing E-Commerce

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Abstract

Collective purchasing is becoming an increasingly popular marketing strategy of online retailers, as electronic marketplace provides a convenient channel for retailers to collect customers physically dispersed worldwide. Participating in collective purchasing, customers can enjoy purchasing with a better price. Online retailers also benefit from the reduction of operational cost by selling a large bundle size of products. However, the customers face a disutility cost from uncertainty and delay during the formation of a collective purchasing group. In this paper, we develop a simple economic model to examine the profitability and social efficiency of collective purchasing strategies under monopolistic and duopolistic market structures.

Keywords: collective purchasing, electronic commerce, pricing strategies, pricing policies, competition, product differentiation

1. Introduction

Online collective purchasing or group purchasing is an activity in which people who desire to buy the same merchandises join together through Internet (Yuan and Lin 2004) in order to get a discount from sellers (Liang and Doong 1998, Muthoo 1999). The dramatic development of Internet technologies and electronic marketplace provide a convenient channel for collective purchasing, comparing with the difficulty of forming a large purchasing group physically. Moreover, sophisticated mobile networking access is allowing customers to become so called "smart mobs" and enlarge their bargaining powers through gathering group members instantly (Rheingold 2003). Collective purchasing is one form of a quantity discount where buyers can beneficially bargain with sellers and purchase goods at quantity discount prices by forming a buyer coalition (Anand and Aron 2003). With the benefit from the reduction of operational costs by selling a large bundle size of products, there emerges an interesting phenomenon that a growing number of commercial electronic stores are providing collective purchasing services. From the perspective of the customers, more and more people are also participating in collective purchasing for better prices (The Economist 2006).

In this paper, we demonstrate that collective purchasing is not only for the purpose of cost reduction, but also as a product differentiation strategy. While customers have the advantage of getting products at a lower price, they face the disutility cost (e.g. waiting time) for a group to be formed. Consequently, collective purchasing becomes less attractive to time sensitive customers. Assuming heterogeneous preference on the disutility cost for each customer during the formation of a collective purchasing group, we develop the pricing scheme of the product bundle. In addition, we examine the profitability and social efficiency of exploiting collective purchasing with respect to monopolistic and duopolistic market structures.

2. Related Literature

Prices for collective purchasing are usually decided by price-quantity functions which are proposed by sellers (e.g. collectivepurchasing.co.uk, GroupBuyCenter.com and Volumebuy.com). Quantity discount schemes based on a customer order with a certain bundle size of goods increases the trade transaction efficiencies in the situations of scale economies Dolan (1987) provides a comprehensive early research survey on quantity discount. Given the bundle size of goods in a customer order, Monahan (1984) utilized the concept of economic order quantity and provided the optimal price-quantity for the supplier. Lee and Rosenblatt (1986) extended the analysis to the situations involving various bundle sizes of goods in customer orders. Weng (1995) included the concepts of operation cost minimization and incentive alignment in market channels. He showed that some incentives are necessary in profit maximization and market channel coordination of quantity discount for price-sensitive customers and scale economies. Kauffman and Wang (2001, 2002) used customer data of an online market operator and analyzed patterns in bidder behavior of group buying. Anad and Aron (2003) analyzed the monopolist's optimal group-buying schedule under the heterogeneity of customer demands, and compared the choice of pricing with the conventional posted-price mechanism. In this paper, we analyze and compare the impact of collective purchasing on the profitability and social welfare under a monopolistic and duopolistic market structures. It shows that the marketing strategy with collective purchasing is superior to the conventional posted-price mechanism.

3. The Model

We consider a market for a homogeneous product sold by a single electronic retailer or two competitive electronic retailers. The retailers have the option of selling a single unit of product (referred as *Instant-Buy* service - buy the product instantly) or/and a large bundle unit of the products (referred as *Group-Purchase* service - collective purchasing). We assume a customer only buys a product. He/She can choose to buy the product directly with a regular price (e.g. from Instant-Buy channel) or join the collective purchasing group to buy the product at a discount price (e.g. from Group-Purchase channel). If a customer selects to participate in the collective purchasing group, he/she needs to wait until the group is finally formed and the reach the targeted size.

3.1. Customer utility functions

Let p_I denote the product's price of Instant-Buy, and p_G the price of Group-Purchase with bundle size q_G . There exists disutility for the customers to participate in formation of collective purchasing group. For example, a buyer may change mind and withdraw his registration before the group is formed or break the agreement to buy the product when the group purchasing order is confirmed. Another natural inconvenience is that the customers have to postpone getting the products. The disutility is heterogeneous to different consumers. Let the disutility cost δ_i of the customers be uniformly distributed with a unit interval. A customer i with higher δ_i has higher impatience on the disutility. Assume each customer buys at most one unit of the products, and attaches the same value V to the product, and V is large enough, relative to consumers' reservation utilities, so in equilibrium, everyone buys a unit. Denote q_I as the number of Instant-Buy customers, and q_G as the number of Group-Purchase customers. The market size is normalized to 1, then have $q_I + q_G = 1$. The utility of a typical consumer i is given by

$$U_i = \begin{cases} V - p_I & \text{if customer } i \text{ buy the product instantly} \\ V - \delta_i q_G - p_G & \text{if customer } i \text{ buy the product through a collective purchasing group} \end{cases} \quad (3.1)$$

3.2. Demand functions

We consider three types of channel configuration:

(1) If only Instant-Buy channel is provided, all the customers buy the product. i.e. $q_I = 1$, for all $p_I < V$.

(2) If only Group-Purchase channel is provided, customers with $\delta_i^2 \leq V - p_G$ will buy the product. The demand functions of the Group-Purchase is given by $q_G = \sqrt{V - p_G}$, for all $p_G < V$.

(3) If both Instant-Buy and Group-Purchasing channels are offered. The market-segmentation condition is given by $V - p_I = V - p_G - q_G \cdot \hat{\delta}$, where customer with impatience index $\hat{\delta}$ is indifferent between from Instant-Buy and Group-Purchase channels. Consequently, customer i with $\delta_i < \hat{\delta}$ will select Group-Purchase; customer i with $\delta_i > \hat{\delta}$ will choose Instant-Purchase. The market share of customers who prefer to Instant-Buy service is $q_I = 1 - \hat{\delta}$, whereas, $q_G = \hat{\delta}$ is that of Group-Purchase service; $\hat{\delta}$ is written as,

$$\hat{\delta} = \begin{cases} 1 & \text{if } p_I - p_G \geq q_G \\ (p_I - p_G) / q_G & \text{if } 0 < p_I - p_G < q_G \\ 0 & \text{if } p_I - p_G \leq 0 \end{cases} \quad (3.2)$$

Thus, the demand functions of Instant-Buy and Group-Purchase are given by

$$q_I = 1 - \sqrt{p_I - p_G}, \quad q_G = \sqrt{p_I - p_G}. \quad (3.3)$$

Assume average marginal transaction (operations) cost per unit is c_I for each unit of Instant-Buy product, and c_G for Group-Purchase product. To ensure the participation and incentive-compatible conditions hold, we assume $c_G \leq c_I$, $c_I \leq p_I \leq V$, and $c_G \leq p_G \leq p_I$.

3.3. Monopolistic Market

A monopolistic retailer provides the customer one of three channels.

(1) Instant-Buy channel: if the monopolistic retailer provides only the Instant-Buy channel, the retailer will set the price for a product to be $p_I = V$. All surplus of the customer is extracted. All customers buy the products ($q_I = 1$) and the retailer's profit is

$$\pi_m^I = V - c_I. \quad (3.4)$$

(2) Group-Purchase channel: if only Group-Purchase is offered, the retailer set the price of a product to be $p_G = V - q_G^2$, and the profit function becomes

$$\max_{p_G} \pi_m^G = (V - q_G^2 - c_G) q_G = V q_G - q_G^3 - c_G q_G. \quad (3.5)$$

The optimal product price for Group-Purchase is given by solving $\partial \pi_m^G / \partial q_G = 0$, and we obtain the equilibrium quantity-price offer

$$B(q_G, p_G) = \left(\sqrt{(V - c_G) / 3}, (2V + c_G) / 3 \right) \quad (3.6)$$

and the profit of the retailer

$$\pi_m^G = 2 \cdot \sqrt[3]{(V - c_G) / 3}. \quad (3.7)$$

(3) Instant-Buy plus Group-Purchase channels: if both Instant-Buy and Group-Purchase channels are adopted, the monopoly's profit-maximizing function is given by

$$\max_{p_I, p_G} \pi_m^{I+G} = \pi_m^I + \pi_m^G = (p_I - c_I) \cdot (1 - \sqrt{p_I - p_G}) + (p_G - c_G) \cdot \sqrt{p_I - p_G}. \quad (3.8)$$

For any Instant-Buy price p_I , the optimal product price of Group-Purchase is given by solving $\partial \pi_m^{I+G} / \partial p_G = 0$, and we get $p_G^* = p_I - \frac{c_I - c_G}{3}$. Thus, the quantity-price offer of group purchasing is

$$B(q_G, p_G) = \left(\sqrt{(c_I - c_G)/3}, V - (c_I - c_G)/3 \right), \quad (3.9)$$

and the overall profit of the monopolistic retailer is obtained as

$$\pi_m^{I+G} = (V - c_I) + 2 \cdot \sqrt[3]{(c_I - c_G)/3}. \quad (3.10)$$

Observation 1. (Monopolistic market) (a) Group-Purchase strategy will be more profitable than Instant-Buy strategy for a monopolistic retailer if transaction cost per unit is c_I sufficiently high such that $c_I > V - 2 \cdot \sqrt[3]{(V - c_G)/3}$. (b) If $c_G < c_I < V - 2 \cdot \sqrt[3]{(V - c_G)/3}$ then the monopolistic retailer will always generate more profit from hybrid-offer than pure offers, and the extra profit is convexly increasing with the reduction degree of transaction cost. (c) In a monopolistic market, optimal bundle size (price) of Group-Purchase offer in pure-offer is larger (smaller) than hybrid-offer.

3.4. Duopolistic Market

In this section, we extend the pricing models to a market with two competitive retailers. These two competitive retailers may choose to adopt the same marketing strategy (e.g. both retailers adopt Instant-Buy strategy), or different ones (e.g. one retailer chooses Instant-Buy strategy, whereas the other one selects Group-Purchase strategy).

(1) Instant-Buy channel VS Instant-Buy channel. If both two competitive retailers adopt Instant-Buy channel, the equilibrium price will be dropped to the marginal transaction cost c_i , and each retailer's profit is 0, because of Bertrand competition of homogeneous product. The equilibrium results become

$$p_{i_i} = c_i, q_{i_i} = \frac{1}{2}, \pi_c^{i_i} = 0, i=1,2. \quad (3.11)$$

(2) Instant-Buy channel VS. Group-Purchase channel. If one retailer adopts Instant-Buy (retailer R_I), whereas the other retailer adopts Group-Purchase strategy (retailer R_G).

Retailer R_I 's optimization problem is written as,

$$\max_{p_I} \pi_c^I = (p_I - c_I) \cdot q_I = (p_I - c_I) \cdot (1 - \sqrt{p_I - p_G}). \quad (3.12)$$

Retailer R_G 's problem is written as,

$$\max_{p_G} \pi_c^G = (p_G - c_G) \cdot q_G = (p_G - c_G) \cdot \sqrt{p_I - p_G}. \quad (3.13)$$

Solving $\partial \pi_c^I / \partial p_I = 0$, and $\partial \pi_c^G / \partial p_G = 0$ simultaneously, we obtain the Nash equilibrium pricing strategies.

$$p_I^* = \frac{1}{5}(3c_I + 2c_G) + \frac{6}{25} \left(1 + \sqrt{1 + 5(c_I - c_G)} \right),$$

$$p_G^* = \frac{1}{5}(2c_I + 3c_G) + \frac{4}{25}\left(1 + \sqrt{1 + 5(c_I - c_G)}\right). \quad (3.14)$$

Then, we have the market share distribution of each retailer,

$$\begin{aligned} q_I^* &= 1 - \frac{1}{5}\sqrt{5(c_I - c_G) + 2\left(1 + \sqrt{1 + 5(c_I - c_G)}\right)}, \\ q_G^* &= \frac{1}{5}\sqrt{5(c_I - c_G) + 2\left(1 + \sqrt{1 + 5(c_I - c_G)}\right)}. \end{aligned} \quad (3.15)$$

If the reduction of transaction cost through group purchasing is very small ($c_G \approx c_I$), then the above results becomes

$$\begin{aligned} p_I^* &\approx c_I + \frac{12}{25}, \quad q_I^* \approx \frac{3}{5}, \quad \pi_c^I \approx \frac{75c_I + 36}{125} \\ p_G^* &\approx c_I + \frac{8}{25}, \quad q_G^* \approx \frac{2}{5}, \quad \pi_c^G \approx \frac{50c_I + 16}{125}. \end{aligned} \quad (3.16)$$

Observation 2. (Duopolistic market) (a) In a duopolistic market, at least one of the two competitive retailers will adopt Group-Purchase strategy. (b) In a duopolistic market, if only one retailer adopts Group-Purchase strategy,

b1. Both the prices of the product through Instant-Buy and Group-Purchase will increase as the difference of transaction costs ($c_I - c_G$) increases.

b2. The market share of the retailer providing Group-Purchase (Instant-Buy) offer will increase (decrease) as the difference of transaction costs ($c_I - c_G$) increases (decreases).

4. Analysis of Economic Efficiency

In this section, we analyze the economic efficiency (social welfare) of different strategies adopted by the retailers in monopolistic and duopolistic markets, and compare them with the socially optimal results. Social welfare of a market is defined as summation of the retailers' profit and the customers' surplus, and is written as,

$$W = \pi_I + \pi_G + \sum_i^n U_i. \quad (4.1)$$

4.1 Monopolistic market

The social welfare gained with respect to different pricing strategies is as follows:

$$(1) \text{ Pure Instant-Buy channel: } W_m^I = V - c_I. \quad (4.2)$$

$$(2) \text{ Pure Group-Purchase channel: } W_m^G = Vq_G - \int_0^{q_G} \delta q_G d\delta - c_G q_G = \frac{5}{2}\sqrt[3]{(V - c_G)/3}. \quad (4.3)$$

(3) Instant-Buy plus Group-Purchase:

$$W_m^{I+G} = V - \int_0^{q_G} \delta q_G d\delta - q_I c_I - q_G c_G = (V - c_I) + \frac{5}{2}\sqrt[3]{(c_I - c_G)/3}. \quad (4.4)$$

4.2. Duopolistic market

The social welfare gained with respect to different pricing strategies is derived as follows:

(1) Instant-Buy VS Instant-Buy:

$$W_c^I = V - c_I, \quad (4.5)$$

(2) Instant-Buy VS Group-Purchase:

$$W_c^{I+G} = (V - c_I) - \frac{q_G^3}{2} + (c_I - c_G)q_G, \quad \text{where } q_G = \frac{1}{5}\sqrt{5(c_I - c_G) + 2\left(1 + \sqrt{1 + 5(c_I - c_G)}\right)}. \quad (4.6)$$

4.3 Socially planned market

The socially optimal market share distribution is discussed as follows

(1) Pure Instant-Buy channel:

$$W_w^I = V - c_I, \quad q_I = 1, \text{ and } c_I \leq p_I \leq V. \quad (4.7)$$

(2) Pure Group-Purchase channel:

$$W_w^G = Vq_G - \int_0^{q_G} \delta q_G d\delta - c_G q_G = Vq_G - c_G q_G - \frac{q_G^3}{2}, \quad (4.8)$$

Solving first order condition,

$$\frac{\partial W_w^G}{\partial q_G} = V - c_G - \frac{3}{2}q_G^2 = 0, \quad (4.9)$$

Socially optimal bundle size, price, and welfare of the market with only pure Group-Purchase offer are

$$q_G = \left(\frac{2}{3}(V - c_G) \right)^{\frac{1}{2}}, \quad p_G = \frac{V + c_G}{3}, \text{ and } W_w^G = \left(\frac{2}{3}(V - c_G) \right)^{\frac{3}{2}}, \text{ respectively.} \quad (4.10)$$

(3) Hybrid strategy: Instant-Buy plus Group-Purchase:

$$W_w^{I+G} = V - \int_0^{q_G} \delta q_G d\delta - q_I c_I - q_G c_G = (V - c_I) - \frac{q_G^3}{2} + (c_I - c_G)q_G \quad (4.11)$$

Solving first order condition

$$\frac{\partial W_w^{I+G}}{\partial q_G} = -\frac{3}{2}q_G^2 + (c_I - c_G) = 0, \quad (4.12)$$

Socially optimal bundle size, prices, and welfare of the market with both Instant-Buy and Group-Purchase offers are

$$q_G = \left(\frac{2}{3}(c_I - c_G) \right)^{\frac{1}{2}}, \quad p_G = p_I - \frac{2}{3}(c_I - c_G), \text{ where } \frac{2}{3}(c_I - c_G) \leq p_I \leq V, \text{ and} \\ W_w^{I+G} = (V - c_I) + \left(\frac{2}{3}(c_I - c_G) \right)^{\frac{3}{2}}. \quad (4.13)$$

Comparing the social welfare derived above, we find $W_w^I > W_w^G$ if and only if, and $W_w^{I+G} > W_w^I$ if and only if $c_I - c_G > 0$.

Observation 3. (Efficient Market) (a) A centrally planned market provides larger bundle size (lower price) of Group-Purchase offer than a monopolistic market. (b) A centrally planned market providing only pure Group-Purchase offer will be more socially efficient than other one providing only pure Instant-Buy offer if transaction cost per unit is c_I sufficiently high such that

$c_I > V - \left(\frac{2}{3}(V - c_G) \right)^{\frac{3}{2}}$. (c) If $c_G < c_I < V - \left(\frac{2}{3}(V - c_G) \right)^{\frac{3}{2}}$, a centrally planned market providing

both Instant-Buy and Group-Purchase offers will be socially optimal.

7. Conclusion

In this paper, we have developed an economic model to evaluate the impact of the collective purchasing strategy on the profitability and efficiency of electronic commerce. In a monopolistic market, collective purchasing is mainly used to reduce the operational cost, however, in a competitive market, collective purchasing can be used as a vertical product differentiation strategy to improve profit, even though the reduction of operational cost is negligible. In

addition to the operational cost, the valuation of products, and market structures also play an important role in deciding the optimal pricing strategy. We compare the profitability and social welfare with respect to the pure strategy (Instant-Buy or Group-Purchase) and the hybrid strategy (combination of Instant-Buy or Group-Purchase) under various market structures, and suggest the conditions under which including collective purchasing in the marketing strategy will be superior.

In a monopolistic market, optimal bundle size (price) of collective purchasing in pure-offer is larger (smaller) than hybrid-offer. A monopolistic market provides smaller bundle size (higher price) of collective purchasing offer than social optimum. In a duopolistic market, if only one retailer adopts the collective purchasing strategy, the market share of the retailer providing collective purchasing will increase as the reduction of the transaction cost increases; furthermore, both the prices of Instant-Buy and Group-Purchase increase as the difference of transaction costs becomes higher.

In our model, we assume that valuation of products is symmetric for all customers. Investigating the corresponding pricing strategies under heterogeneous production valuation and social cost (uncertainty and delay cost) is a planned future extension. In the model, the operational cost of collective purchasing is assumed to be an exogenous parameter. It will be interesting to study how our results will change if the reduction of the operational cost is endogenous and is associated with the collective purchasing group size. Besides the investigation of single bundle size of collective purchasing, an interesting topic for future research is to study the provision of multiple bundle size offers, in which a retailer can provide several bundle sizes for various collective purchasing groups.

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